

## **Remarks**

Claims 1 - 12 are pending. Favorable reconsideration is respectfully requested.

The claimed invention is directed to sprayable, fiber-reinforced, strain-hardening mortar compositions which contain a cement fraction (inorganic binder), a strain hardening amount of specific reinforcing fibers having interfacial chemical bonding less than 4.0 J/m<sup>2</sup>, water, a super plasticizer, a viscosity control agent, and at least one non-Newtonian additive such that the mixture is pumpable and sprayable, yet which exhibits a higher viscosity after spraying, the latter property allowing for greater thickness of sprayable mortar on vertical and inverted surfaces.

The claims have been rejected for obviousness-type double patenting over three references, all naming Victor Li as one of the inventors, and all commonly assigned to the Regents of The University of Michigan. In actuality, there are only two references, since published application 2002/0019465 A1 is the application from which U.S. patent 6,809,131 B2 is derived.

Applicants do not agree that there is an obviousness-type double patenting problem here, as the claimed compositions are quite distinct, sharing only the fact that each is a strain-hardening composition containing reinforcing fibers. However, to expedite prosecution, accompanying this response is a Terminal Disclaimer disclaiming the term of the present application over the unshortened term of U.S. 6,809,131 and any patent issuing from U.S. Serial No. 10/674,772 (US2005/0066857 A1). Withdrawal of the obviousness-type double patenting rejections is solicited.

Several rejections of the claims under 35 U.S.C. § 112 have been maintained. With respect to claim 8, the term "modulus" has been replaced with the original term "density". The Examiner alleges that "high" is a relative term and therefore indefinite. The term "high" is not to be read in isolation, but is part of the name of a well defined family of

Polyethylene polymers, "high density polyethylene," sometimes also called "high modulus polyethylene." High density polyethylene is produced using catalysts which minimize branching, particularly long chain branching. The existence of practically no branching, or only of minimal short chain branching, leads to the ability to produce polymers with higher mechanical properties than low density polyethylene (LDPE). High density polyethylene has a density in excess of 0.941, and generally in the range of 0.941 to 0.965. Attached are several articles downloaded from the internet which define high density polyethylene. The definitions can also be found in numerous treatises and U.S. patents on polyethylene synthesis as well, and thus the term is well known to those skilled in the art. Withdrawal of claim 8 under 35 U.S.C. § 112 is solicited.

The rejection of claims 1- 12 for use of "cement fraction" and "hydraulically setting cements" in view of the use of calcium aluminate cement was discussed in Applicants' prior response, page 8, second paragraph. Applicants have defined the term "hydraulically setting cement" on page 7, lines 4 - 7 of the application as not including calcium aluminate cement. It is well established that a patentee can be his own lexicographer, and the definition of "hydraulically setting cement" causes there to be no overlap when calcium aluminate cement is used as an associative thickener, since calcium aluminate cement in Applicants' definition, is not a hydraulically setting cement as that term has been defined. However, to avoid argument on this issue, Applicants have amended claim 1 to recite that the hydraulically setting cement is "other than calcium aluminate cement." Support may be found on page 7, lines 4 - 7. With respect to claim 13, applicants do not agree that the claim is indefinite, as one can easily determine whether any particular composition would infringe this claim, by simply comparing the parts of the ingredients specified. However, only for the purposes of expediting prosecution, this claim has been cancelled. Applicants therefore respectfully solicit withdrawal of the rejection of claims 1 - 12 under 35 U.S.C. § 112.

Finally, the Examiner has objected to the term "associative thickener". Applicants have directed the Examiner's attention to Deck et al. U.S. Patent 4,640,791, "Water-based Functional Fluids Thickened by the Interaction of an Associative Polyether

Thickener and Certain Fatty Acid Amides”, which refers to the earlier Panek et al. U.S. Patent 4,11,819, “Thickening Aqueous Compositions With Polyethers Modified With Alpha-Olefin Oxides” and 4,312,775 “Polyether Thickeners For Aqueous Systems Containing Additives for Increased Thickening Efficiency”. Reference may also be had to Camp U.S. Patent 4,288,639, “Alpha-Olefin Oxide-Modified Liquid Polyether Thickeners” and Owens et al. U.S. 4,673,518, “Synthetic Polyether Thickeners and Thickened Aqueous Systems Containing Them.” All these references, with the exception of U.S. 4,312,775, are already of record. The term “associative thickener” was coined at least by the 1980's, and pertains to moderate weight hydrophilic polymers with a plurality of long chain hydrophobes. In aqueous environments, the hydrophobes “associate” and produce very long “associated molecules” which markedly increase viscosity under conditions of low shear. At higher shear rates, the weak association of hydrophobes is broken and the molecules, now being much smaller, lose the majority of their thickening effect. The term “associative thickener” is well known, and for example is contained in some 269 patents since 1976 (search of United States Patent and Trademark Office database: “associative thickener”). A recent example is Goldoni et al. U.S. published application 2004/0168275. Many scholarly articles and treatises also discuss and define this term, and these may easily be identified by a quick Google search. These treatises and articles are not available to Applicants, however, and therefore have not been supplied. However, it is evident that the term is well known in the art, and withdrawal of the rejection of claim 5 for use of this term is solicited.

Claims 1 - 12 have been rejected under 35 U.S.C. § 103(a) over Baeuml et. al. U.S. Patent 6,824,607 B2 (“*Baeuml*”), Kodama et al. JP 2001 220188 Abstract (“*Kodama*”), or Kanda et al. JP 2002 193653 Abstract (“*Kanda*”), all individually. Applicants respectfully traverse these rejections.

The subject invention claims are directed to strain hardening compositions containing specific fibers, super plasticizer, and non-Newtonian additive, among the other ingredients, and which are pumpable and sprayable. The Office bases its rejections on the

premise that these references “teach the same components in overlapping amounts.” However, this is incorrect.

*Kodama* teaches a “lightweight” cementitious coating material, but fails to indicate whether it is pumpable or sprayable. Most cementitious materials are not pumpable or sprayable, but are applied by conventional hand or casting techniques. Moreover, and most importantly, *Kodama* fails to teach or suggest that his compositions are strain hardening (most are not); fails to teach or suggest the use of any non-Newtonian additive; and fails to teach or suggest inclusion of 0.1 to 4.0 volume percent of 4 - 30 mm length, 10  $\mu\text{m}$  to 150  $\mu\text{m}$  diameter fibers with interfacial chemical bonding of less than 4.0 J/m<sup>2</sup>. The *Kodama* abstract cites “polyamide fibers, uses” at the bottom of the abstract in the “IT” section, however, there is no indication that these fibers are added to the cement. They may, for example, be included in the forms into which the cement is poured or in reinforcing bars, etc. Even if added to cement, there is no indication that these fibers meet the volume percent, size, or interfacial chemical bonding requirements of the claims. The presence of 15 mm aggregate (0.6 inch) would appear to confirm that the *Kodama* compositions are not pumpable or sprayable. However, as stated previously, there is no disclosure of any non-Newtonian additive, nor of fiber content, characteristics, etc., and no indication that fibers are even added to the composition. As *Kodama* neither teaches or suggests any of these claim limitations, withdrawal of the rejection of the claims over *Kodama* under 35 U.S.C. § 103(a) is solicited.

*Kanda* discloses cementitious repairing materials containing 1 to 3 volume percent of polyvinyl alcohol fibers, which exhibits a tensile strain of > 1 %. However, first, *Kanda* does not disclose that his compositions are strain hardening. Strain hardening compositions exhibit an increase in tensile stress versus strain, and there is no indication that *Kanda*’s compositions meet this requirement. The tensile stress may remain constant or decrease with tensile strain until failure occurs. Second, while the fiber sizes and lengths of *Kanda* and their amount meet the limitations of claim 1, there is no indication that these fibers also have interfacial chemical bonding of less than 4.0 J/m<sup>2</sup>. While *Kanda* uses polyvinylalcohol fibers as also do Applicants, the fibers employed by Applicants are oiled

fibers (K-II REC™), with an oil content of 0.8 weight percent to lower interfacial chemical bonding to below 4.0 J/m<sup>2</sup>. There is no indication that the *Kanda* fibers are so treated. If the fibers are too strongly attracted to the cement matrix, the fibers cannot release from the matrix as crack formation occurs. Thus, rather than the cracks being able to spread apart and distribute the load placed upon the structure, the fibers will be stressed in place until they fail, generally resulting in catastrophic failure of the structure.

Most importantly, however, *Kanda* completely fails to disclose, teach, or suggest any non-Newtonian additive. Unlike *Kodama*, *Kanda* indicates that his compositions are pumpable and sprayable. However, a non-Newtonian additive is an important feature of the claims which distinguishes Applicants' invention from other sprayable mortars. Since *Kanda* does not teach or suggest this limitation, the claims are non-obvious over *Kanda*, and for this and the foregoing reasons, the rejection under 35 U.S.C. § 103(a) should be withdrawn.

*Baeuml* is directed to cementitious compositions which can be applied to concrete structures containing steel reinforcement, in which corrosion inhibitors are present and may migrate into the previously poured and now damaged structure to prevent further corrosion of the reinforcement.

*Baeuml* teaches that fibers may be added, and appears to teach strain hardening (extensional strengthening) as well. However, *Baeuml* is silent regarding the interfacial chemical bonding of these fibers, and includes fibers such as steel which are known not to produce strain hardening behavior, and "polyolefins" in general, which includes polypropylene, also not known to produce such behavior. In the absence of any teaching of the interfacial chemical bonding limitation, *Baeuml* is not a non-obviousness defeating reference.

However, more importantly, *Baeuml* makes no use of any non-Newtonian additive, nor does he teach or suggest that such an additive be added. In the absence of such

a teaching, the claims are non-obvious over *Baeuml* for this reason also, and withdrawal of the rejection of the claims over *Baeuml* under 35 U.S.C. § 103(a) is solicited.

Applicants submit that the claims are now in condition for Allowance, and respectfully request a Notice to that effect. If the Examiner believes that further discussion will advance the prosecution of the Application, the Examiner is highly encouraged to telephone Applicants' attorney at the number given below.

Respectfully submitted,

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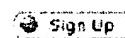


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## Polyethylene

### PE

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A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

**Definition:** A family of resins prepared from the polymerization of ethylene gas using a variety of catalysts. Density, melt index, crystallinity, degree of branching and cross-linking, molecular weight and molecular weight distribution can be regulated over wide ranges. Further modifications are obtained by copolymerization, chlorination, and compounding additives. Polymers with densities ranging from about 0.910 to 0.925 are called low density polyethylene, those of densities from 0.926 to 0.940 are called medium density, and those of densities from 0.941 to 0.965 and over are called high density polyethylene. The low density types are polymerized at very high pressures and temperatures, and the high density types at relatively low pressures and temperatures. Two other types are extra high molecular weight (EHW) materials having molecular weights in the range 150,000 to 1,500,000 and ultra high molecular weight (UHMW) materials in the 1,500,000 to 3,000,000 range. When fully cross-linked by irradiation or by the use of chemical additives, they are no longer thermoplastics. Cured during or after molding they become true thermosets with good tensile strength, electrical properties and impact strength over a wide range of temperatures. Glass fiber reinforced polyethylene can be processed by injection molding, rotational

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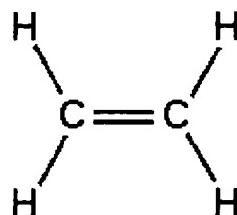
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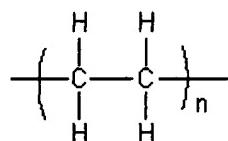
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In the polymer industry the name is sometimes shortened to **PE**, similar to how other polymers like polypropylene and polystyrene are shortened to **PP** and **PS**, respectively. In the United Kingdom the polymer is called **polythene**. (e.g. in the Beatles song Polythene Pam).

The ethene molecule (known almost universally by its non-IUPAC name ethylene),  $C_2H_4$  is  $CH_2 = CH_2$ , Two  $CH_2$  connected by a double bond, thus:



Polyethylene is created through polymerization of ethene. It can be produced through radical polymerization, anionic polymerization, and cationic polymerization. This is because ethene does not have any substituent groups which influence the stability of the propagation head of the polymer. Each of these methods results in a different type of polyethylene.



### Classification of polyethylenes

Polyethylene is classified into several different categories based mostly on its mechanical properties. The mechanical properties of PE depend significantly on variables such as the extent and type of branching, the crystal structure, and the molecular weight.

- UHMWPE (ultra high molecular weight PE)
- HDPE (high density PE)
- LDPE (low density PE)
- LLDPE (linear low density PE)

UHMWPE is polyethylene with a molecular weight numbering in the millions. The high molecular weight results a very good packing of the chains into the crystal structure. This results in a very tough material. UHMWPE is made through metallocene catalysis polymerization.

HDPE has little branching and thus stronger intermolecular forces and tensile strength. The lack of branching is ensured by an appropriate choice of catalyst (e.g. Ziegler-Natta catalysts) and reaction conditions.

LDPE has many more branches than HDPE, which means that the chains do pack into the crystal structure as well. It has therefore less strong intermolecular forces as the instantaneous-dipole induced-dipole attraction is less. This results in a lower tensile strength and increased ductility. LDPE is created by free radical polymerization.

LLDPE is a substantially linear polymer, with significant numbers of short branches, commonly made by copolymerization of ethylene with longer-chain olefins.

UHMWPE is used in high modulus fibers and in bulletproof vests. The most common household use of HDPE is in containers for milk, liquid laundry detergent, etc; the most common household use of LDPE is in plastic bags. LLDPE is used primarily in flexible tubing.

Recently, much research activity has focused on Long Chain Branched polyethylene. This is essentially HDPE, but has a small amount (perhaps 1 in 100 or 1000 branches per backbone carbon) of very long branches. These materials combine

the strength of HDPE with the processability of LDPE.

## History

Polyethylene was first synthesized by the German chemist Hans von Pechmann, who prepared it by accident in 1898 while heating diazomethane. When his colleagues Eugen Bamberger and Friedrich Tschirner characterized the white, waxy substance he had created, they recognized that it contained long -CH<sub>2</sub>- chains and termed it *polymethylene*.

The first industrially practical polyethylene synthesis was discovered (again by accident) by Eric Fawcett and Reginald Gibson at ICI Chemicals in 1933. Upon applying extremely high pressure (several hundred atmospheres) to a mixture of ethylene and benzaldehyde, they again produced a white waxy material. Since the reaction had been initiated by trace oxygen contamination in their apparatus, the experiment was at first difficult to reproduce. It was not until 1935 that another ICI chemist, Michael Perrin, developed this accident into a reproducible high-pressure synthesis for polyethylene that became the basis for industrial LDPE production beginning in 1939.

Subsequent landmarks in polyethylene synthesis have centered around the development of several types of catalyst that promote ethylene polymerization at more mild temperatures and pressures. The first of these was a chromium trioxide based catalyst discovered in 1951 by Robert Banks and John Hogan at Phillips Petroleum. In 1953, the German chemist Karl Ziegler developed a catalytic system based on titanium halides and organoaluminum compounds that worked at even milder conditions than the Phillips catalyst. The Phillips catalyst is less expensive and easier to work with, leading to both methods being used in industrial practice.

By the end of the 1950s both the Phillips and Ziegler type catalysts were being used for HDPE production. Phillips' initially had difficulties producing a HDPE product of uniform quality, and filled warehouses with off-specification plastic. However, financial ruin was unexpectedly averted in 1957, when the hula hoop, a toy consisting of a circular polyethylene tube, became a fad among teenagers throughout the United States.

A third type of catalytic system, one based on metallocenes, was discovered in 1976 in Germany by Walter Kaminsky and Hansjörg Sinn. The Ziegler and metallocene catalyst families have since proven to be very flexible at copolymerizing ethylene with other olefins and have become the basis for the wide range of polyethylene resins available today, including VLDPE, LLDPE, and MDPE. Such resins, in the form of fibers like Dyneema, have (as of 2005) begun to replace aramids in many high-strength applications.

Until recently, the metallocenes were the most active single-site catalysts for ethylene polymerisation known - new catalysts are typically compared to zirconocene dichloride. Much effort is currently being exerted on developing new single-site (so-called post-metallocene) catalysts, that may allow greater tuning of the polymer structure than is possible with metallocenes. Recently, work by Fujita at the Mitsui corporation has demonstrated that certain iminophenolate complexes of Group IV metals show substantially higher activity than the metallocenes.

## Physical Properties

Depending on the crystallinity and molecular weight, a melting point and glass transition may or may not be observable. The temperature at which these occur varies strongly with the type of PE.

## References

1. [Macrogalleria](#)

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## Translations

